इंटरनेट मानक

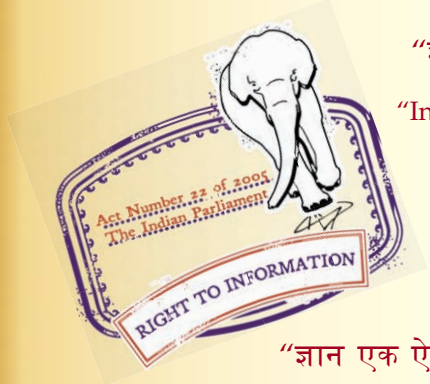
Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 6088 (1988): Specification for Oil-to-water Heat Exchangers for Transformers [MED 17: Chemical Engineering Plants and Related Equipment]



"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

BLANK PAGE

Indian Standard (Reaffirmed 1999)

SPECIFICATION FOR OIL-TO-WATER HEAT EXCHANGERS FOR TRANSFORMERS

(First Revision)

Chemical Engineering Sectional Committee, EDC 57; Heat Generation and Heat Transfer Equipment Subcommittee, EDC 57 : 3 [Ref: Doc : EDC 57 (4901)]

1. Scope — Covers material, construction and testing requirements of oil-to-water heat exchangers for transformers.

2. Types and Rating

2.1 *Types* — The heat exchangers shall be of Types A, B, C and D depending upon the position of oil and water connections. These may be either suspended mounted (SM) or base mounted (BM) heat exchangers as shown in Fig. 1 and 2, respectively.

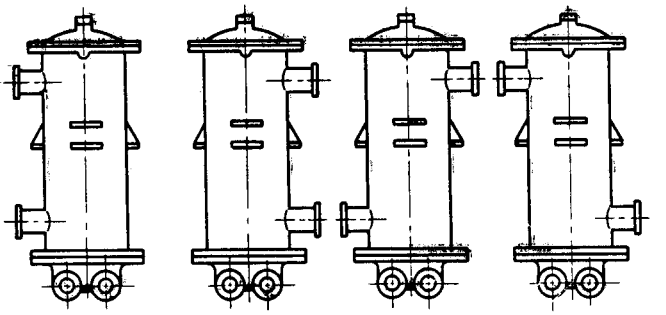


FIG. 1 SUSPENDED MOUNTED (SM) TYPE HEAT EXCHANGERS

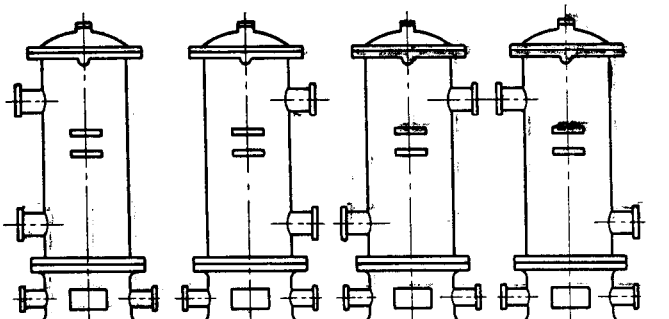


FIG. 2 BASE MOUNTED (BM) TYPE HEAT EXCHANGERS

2.2 *Rating* — The heat exchangers shall be rated according to their guaranteed heat dissipation capacity. It shall be one of the following:

50, 100, 160, 250, 350, 400, 500, 630, 800, 1 000, 1 600 kW

Adopted 5 August 1988 Gr 6

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

3. Material — The material used for various components of heat exchangers shall not be of a quality inferior to those specified below. Any other material equal or superior in performance to those specified may be used, subject to agreement between the manufacturer and the user.

3.1 *Shell* — The steel used for the construction of shell shall be at least equivalent to Grade A of IS : 2062-1984 'Specification for weldable structural steel (*third revision*)'.

3.2 *Tube Plates* — The material used for the tube plates shall be leaded brass to naval Grade B of IS : 8362-1977 'Specification for copper and copper alloy rolled plates for condensers and heat exchangers' or mild steel to Grade A of IS : 2062-1984, as may be agreed to between the manufacturer and the user.

3.3 *Tubes* — The material used for the tubes shall be solid drawn admirality brass to IS : 1545-1982 'Specification for solid drawn copper alloy tubes for condensers and heat exchangers (*second revision*)'. Only those tubes on which the pressure tests in accordance with the requirements for the relevant standards have been carried out shall be used.

3.4 *Baffles* — The steel used for the baffle shall conform to IS : 2062-1984.

3.5 *Water Chamber* — The steel used for the construction of the water chamber shall conform to Grade A of IS : 2062-1984. Alternatively, the water chamber may be constructed of Grade 15 of cast iron conforming to IS : 210-1978 'Specification for grey iron castings (*third revision*)'.

3.6 *Cover* — The material for the cover shall conform to Grade A of IS : 2062-1984.

3.7 *Components* — The material of the component parts (*see* Fig. 3 and 4) shall be as given below:

Sl No.	*Description*	*Remarks*
1	Welding neck flange, 15 mm nominal size, Class 6·3	Conforming to IS : 6392-1971 'Specification for steel pipe flanges'
2	Cover	—
3	Screw plug P3/4	Conforming to IS : 554-1975 'Dimensions for pipe threads where pressure tight joints are required on the threads (*second revision*)'
4	Plate mounting	—
5	Access cover for cleaning water space	—
6	Thermometer pocket P3/4	*See* **5**
7	Thermometer connection P3/4	*See* **5**
8	Welding neck flange, Class 10	Conforming to IS : 6392-1971, nominal bore according to d_3
9	Welding neck flange, Class 10	Conforming to IS : 6392-1971, nominal bore according to d_4 at the manufacturer's option

4. Design, Dimensions and Finish

4.1 *Design* — The heat exchanger shall be designed in accordance with the requirements of IS : 4503-1967 'Specification for shell and tube type heat exchangers'. General requirements for transformer heat exchangers are given in Table 1. It shall be so designed that it may be mounted and protected in the open, without rain water or condensate collecting on it with the consequent risk of damage to joints. The tubes shall be of the seamless drawn type expanded in the tube plate. The tube bundle shall be of the floating type and capable of withdrawal when necessary. The water chambers shall be removed and capable of being emptied. In the case of the suspended mounting type, the design shall be such that the removal of the water chambers does not affect the oil circuit.

TABLE 1 GENERAL REQUIREMENTS FOR TRANSFORMER HEAT EXCHANGERS

(Clause 4.1)

Heat Dissipation Rating kW	Volume of Oil Circulated m^3/h	Volume of Water m^3/h	Pressure Drop *Max*		Oil Temperature		Water Temperature		Oil Filling Capacity* l	Weight of Heat Exchanger When Empty *Max* kg
			Oil MPa	Water MPa	Inlet °C	Outlet °C	Inlet °C	Outlet °C		
50	17	4·5	0·04	0·01	70	63·5	35	45	45	150
100	33	9·0							60	240
160	53	13·5							90	300
250	82	22·5	0·05	0·015					120	420
350	116	31·5							170	530
400	135	36							240	580
500	170	45	0·06	0·02					300	600
630	210	57							375	720
800	270	72							480	760
1 000	340	90							600	1 000
1 600	540	144							800	1 400

*Capacity of the oil in the tube side of heat exchangers when filled initialiy with oil.

4.1.1 Account shall be taken of the fouling factor in designing the heat exchangers. The minimum fouling resistance shall be as follows:

a) Transformer oil	0·000 2	$\frac{hm^{2\circ}C}{kCal}$
b) Sea water	0·000 1	,,
c) Brackish water or river water	0·000 2	,,

A free exit of water without any scope to build up pressure shall be ensured. The oil pressure shall be higher than the water pressure.

4.1.2 The velocity of water in the heat exchanger shall not be less than 1 m/s.

4.1.3 Minimum outside diameter of tube shall be 12·7 mm.

4.1.4 Minimum tube thickness shall be 0·89 mm.

4.1.5 Tube pitch shall be 1·20 times tube outer diameter (OD) for tube OD less than 16 mm and 1·25 times tube OD for tube OD greater than 16 mm.

4.1.6 Tube pattern shall be 60° triangular pitch.

4.1.7 Maximum tube hole size in baffle plate shall be the tube OD plus 0·4 mm.

4.1.8 *Clearance between shell inner diameter (ID) and baffle OD*

4.1.8.1 *Disc and doughnut baffle arrangement*

a) Maximum radial clearance at any point between shell ID and doughnut baffle OD shall not exceed 3·0 mm including the ovality of the shell, and

b) The ovality of the shell shall be limited to a maximum of 3·0 mm on diameter.

4.1.8.2 *Segmental baffle arrangement* — Maximum of design shell ID minus baffle OD shall not exceed the following values:

Shell ID	*Clearance*
⩽ 400 mm	3·0 mm
401 to 1 000 mm	5·0 mm
1 001 to 1 400 mm	6·0 mm
1 401 and above	8·0 mm

4.2 *Dimensions* — The dimensions of the suspended mounted heat exchangers shall conform to the requirements given in Table 2 read with Fig. 3 and those of the base mounted heat exchangers shall conform to the dimensions given in Table 3 read with Fig. 4.

4.2.1 *Tolerances* — Permissible deviations from dimensions specified in Tables 2 and 3 without tolerance indication shall be the coarse class specified in IS : 2102-1980 'General tolerance for dimensions and form and position' except in the case of dimensions e_4 and e_6 which shall be of the medium class.

4.2.2 The dimensions of the cover shall conform to those given in Fig. 5. Alternatively, the cover may be bolted to the water box using studs or bolts with suitable jointing material to give a leak-proof joint.

4.3 *Finish* — The external surface of the heat exchanger shall be spray galvanized to a total thickness of not less than 0·12 mm which is equal to applying not less than 600 g/m² by the spraying method. Subject to agreement between the manufacturer and the user, the external surface may be painted instead of spray galvanizing. The interior surface of the water chambers shall be painted with rust protection paint. All bolts and nuts shall be protected against corrosion or made of corrosion resistant material.

5. Monitoring Equipment — The heat exchangers may be provided with the following equipment subject to agreement between the manufacturer and the user:

a) Thermometer on the oil side [depth of immersion 100 mm, thread P3/4 × 20 mm (*see* IS : 554-1975, flange diameter 38 mm];

b) Thermometer on the water side [depth of immersion 65 mm, thread P3/4 × 20 mm (*see* IS : 554-1975), flange diameter 38 mm];

c) Pressure gauge on oil outlet and water inlet to IS : 3624-1979 'Specification for pressure and vacuum gauges (*first revision*)', thread P1/2 (*see* IS : 554-1975);

d) Flow monitor on oil outlet and water inlet;

e) Water overflow pipe communicating, at option, with vent plug on upper water chamber;

f) Differential pressure monitor. This is connected to the oil outlet and water inlet. The oil side connection is made to one of the two flanges under Sl No. 1 in **3.7**; and

g) Device fitted at the water outlet to indicate any leakage of oil-to-water.

6. Testing — The leakage test is carried out with the transformer oil at room temperature and at a pressure of 1 MPa or one-and-a-half times the design pressure, whichever is greater, and with the pressure of 0·5 MPa or one-and-a-half times the design pressure, whichever is greater, maintained on the water side. Reckoning from the time the last leak occurs, the test pressure may be maintained for two hours, both on the oil side and on the water side. At the end of this time, there shall be no evidence of further leakage.

7. Designation — The designation of the heat exchangers to this specification shall include the following information:

a) Common name,

b) Type,

c) Cooling rating, and

d) Designation of this standard.

Examples:

An oil-to-water heat exchanger for base mounting (BM) Type A with a heat dissipation rating of 100 kW is designated as:

Heat Exchanger BM A 100, IS : 6088

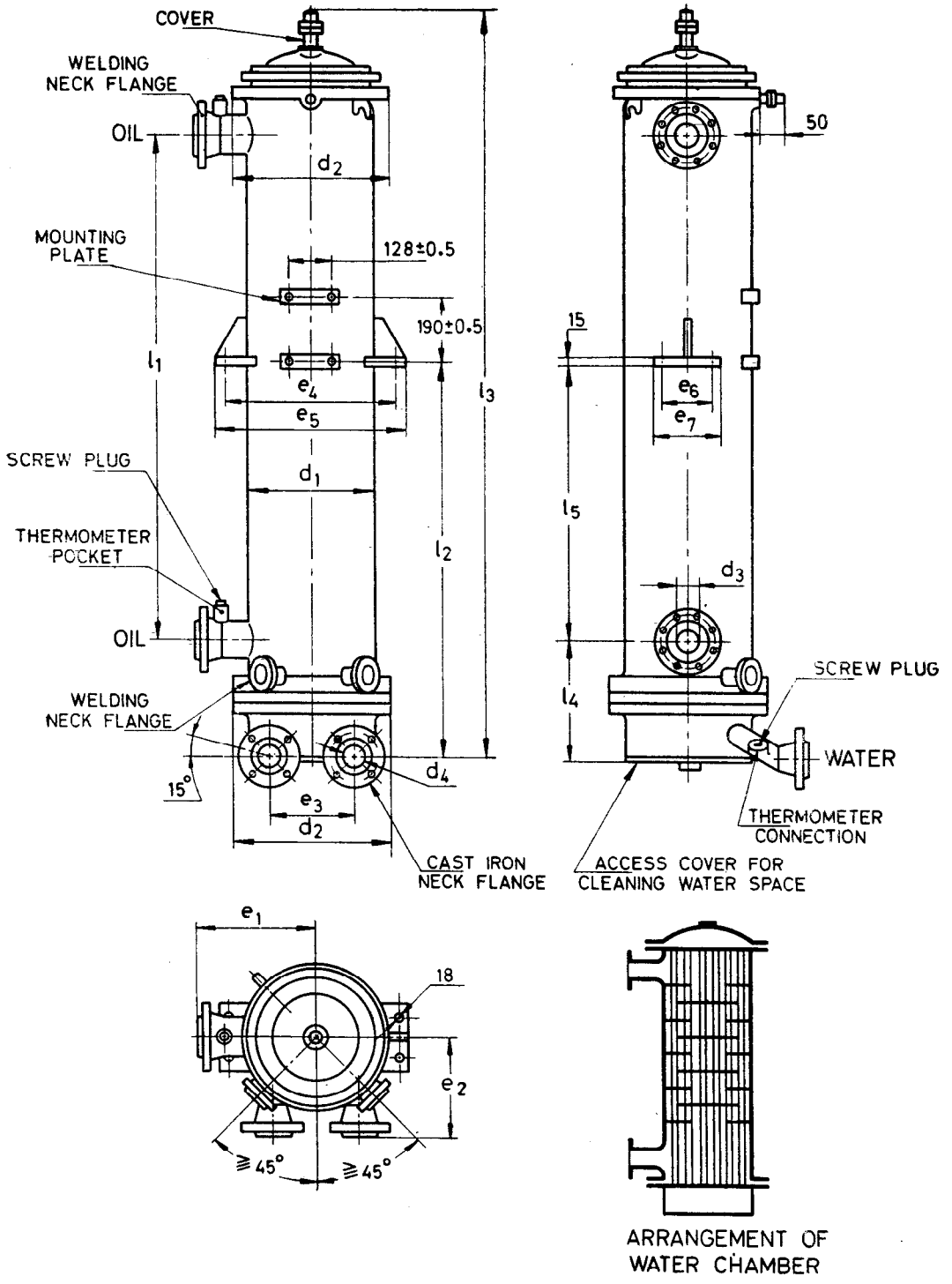
8. Sampling

8.1 *Lot* — In consignment, all the oil-to-water heat exchangers of the same designation manufactured from the same material under similar conditions of production shall be grouped together to constitute a lot.

8.2 For ascertaining the conformity of the lot, the procedure for sampling and inspection as given in IS : 2500 (Part 1)-1973 'Sampling inspection tables: Part 1 Inspection by attributes and by count of defects (*first revision*)' shall be followed. The type of sampling plan, inspection level and acceptable quality level (AQL) to be followed for various characteristics shall be as given in **8.2.1** and **8.2.2.**

8.2.1 For ascertaining the conformity of the lot with respect to dimensions, design and designation, a single sampling plan with inspection level IV and AQL of 1·5 percent as given in Table 1 and 2 of IS : 2500 (Part 1)-1973 shall be followed.

8.2.2 For ascertaining the conformity of the lot with respect to finish and leakage test, a single sampling plan with inspection level III and AQL of 1·5 percent as given in Tables 1 and 2 of IS : 2500 (Part 1)-1973 shall be followed.



All dimensions in millimetres.

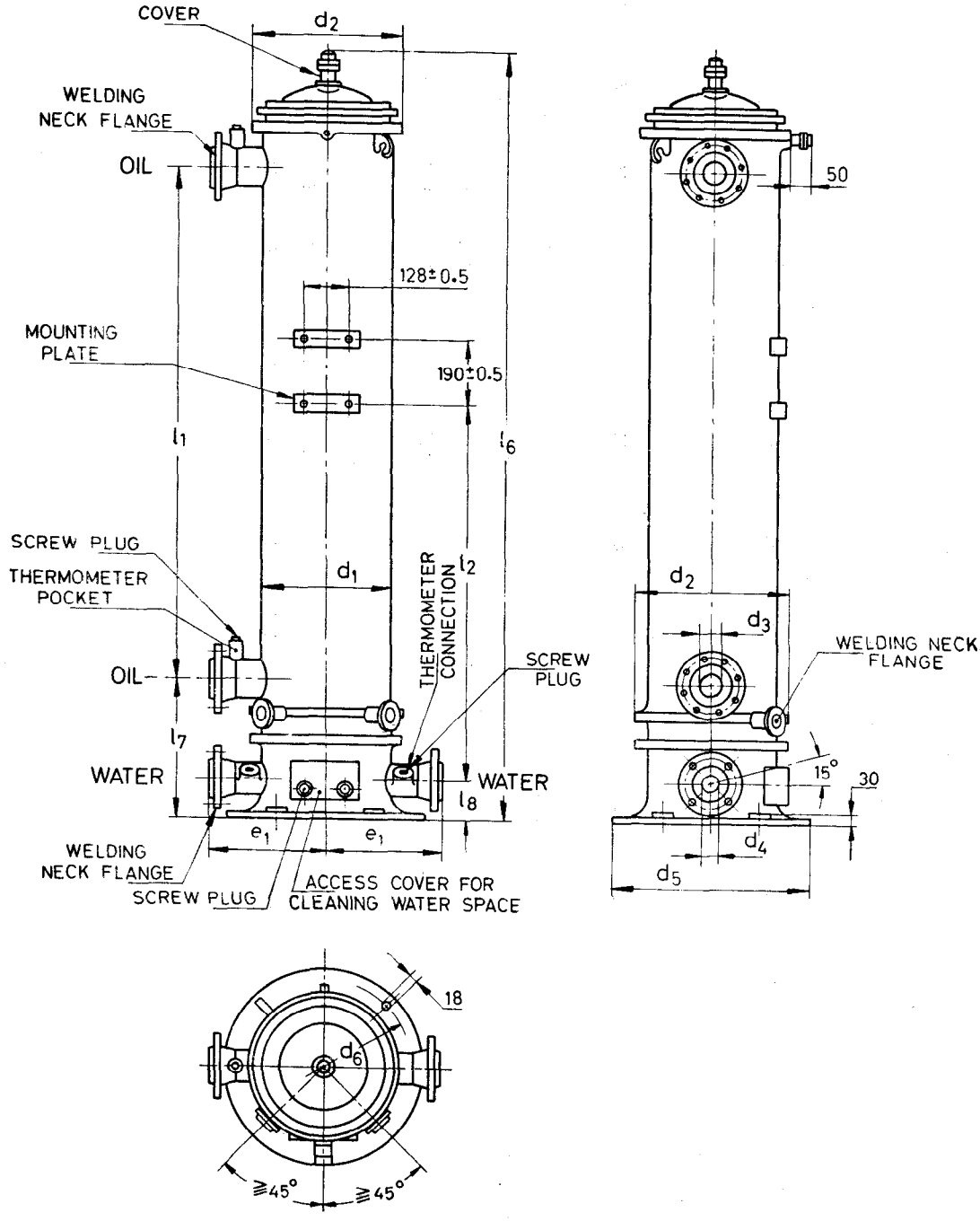
FIG. 3 DIMENSIONS FOR SUSPENDED MOUNTED (SM) HEAT EXCHANGER

TABLE 2 DIMENSIONS OF SUSPENDED MOUNTED HEAT EXCHANGERS

(*Clauses* 4.2, 4.2.1 and *Fig.* 3)

All dimensions in millimetres.

Heat Dissipation Rating kW	d_1	d_2	d_3	d_4	e_1	e_2	e_3	e_4	e_5	e_6	e_7	l_1	l_2	l_3 Max	l_4 Max	l_5 ±2
50	200 to 220	270 to 290	65	40	225	160	155	320	360	60	100	1 000	750	1 415	235	550
100	250 ,, 280	330 ,, 360	65	40	260	190	160	380	420	100	150	1 085	820	1 545	260	595
160	290 ,, 320	370 ,, 400	100	50	275	220	180	450	500	100	150	1 160	820	1 655	285	575
250	340 ,, 370	430 ,, 460	125	50	300	235	200	460	510	150	200	1 320	1 100	1 870	300	835
350	380 ,, 420	470 ,, 510	125	65	325	255	250	520	570	150	200	1 500	1 100	2 050	340	810
400	380 ,, 420	470 ,, 510	125	65	325	255	250	520	570	150	200	1 500	1 100	2 050	340	810
500	380 ,, 420	470 ,, 510	125	65	325	255	250	520	570	150	200	1 500	1 100	2 050	340	810
630	450 ,, 500	540 ,, 600	150	80	380	315	350	600	650	190	250	1 860	1 320	2 450	375	1 000
800	450 ,, 500	540 ,, 600	150	80	380	315	350	600	650	190	250	1 860	1 320	2 450	375	1 000
1 000	510 ,, 550	620 ,, 670	200	100	420	350	400	650	700	200	280	2 140	1 510	2 830	410	1 150
1 600	580 ,, 630	700 ,, 750	200	100	460	390	400	730	780	200	280	2 140	1 510	2 830	410	1 150



All dimensions in millimetres.

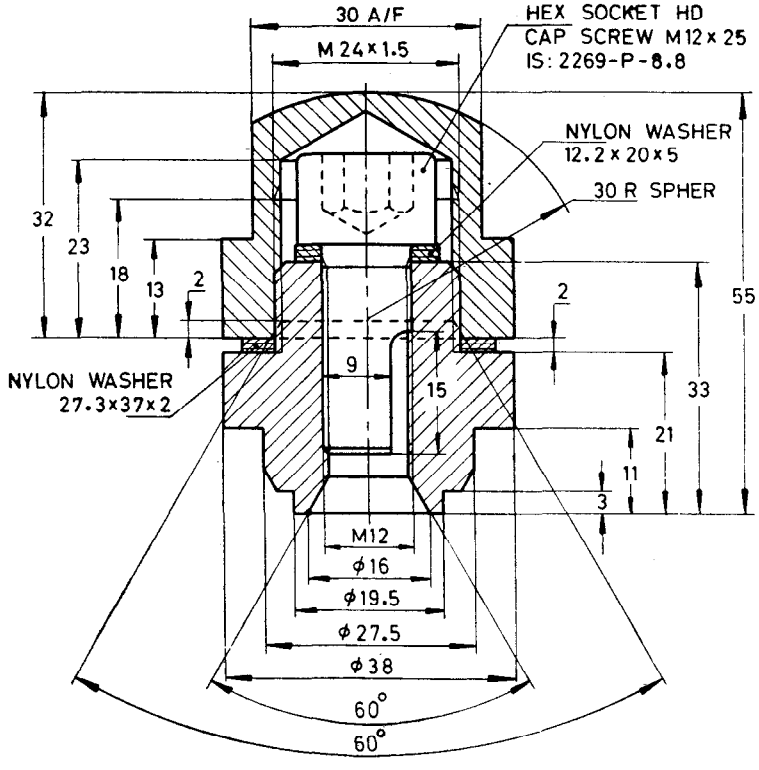
FIG. 4 DIMENSIONS FOR BASE MOUNTED (BM) HEAT EXCHANGER

TABLE 3 DIMENSIONS OF BASE MOUNTED HEAT EXCHANGERS

(*Clauses* 4.2, 4.2.1 and *Fig.* 4)

All dimensions in millimetres.

Heat Dissipation Rating kW	d_1	d_2	d_3	d_4	d_5	d_6	e_1	l_1	l_2	l_6 Max	l_7 ±2	l_8
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
50	200 to 290	270 to 290	65	40	360	310	225	1 000	750	1 515	300	100
100	250 ,, 280	330 ,, 360	66	40	430	380	260	1 085	820	1 645	325	100
160	290 ,, 320	370 ,, 400	100	50	480	430	275	1 160	820	1 765	355	110
250	340 ,, 370	430 ,, 460	125	50	530	480	300	1 320	1 100	1 995	390	125
350	380 ,, 420	470 ,, 510	125	65	570	520	325	1 500	1 100	2 175	415	125
400	380 ,, 420	470 ,, 510	125	65	570	520	325	1 500	1 100	2 175	415	125
500	380 ,, 420	470 ,, 510	125	65	570	520	325	1 500	1 100	2 175	415	125
630	450 ,, 500	540 ,, 600	150	80	630	580	380	1 860	1 200	2 580	450	130
800	450 ,, 500	540 ,, 600	150	80	630	580	380	1 860	1 200	2 580	450	130
1 000	510 ,, 550	620 ,, 670	200	100	700	650	420	2 140	1 300	2 990	500	140
1 600	580 ,, 630	700 ,, 750	200	100	780	730	460	2 500	1 400	3 350	500	140



All dimensions in millimetres.

FIG. 5 DIMENSIONS FOR COVER

9. Marking — A rating plate carrying the following information shall be mounted on the position shown in Fig. 3 and 4:

a) Manufacturer's name or trade-mark;

b) Type of heat exchanger;

c) Heat dissipation rating in kW;

d) Volume of oil circulated in m^3/h;

e) Volume of water circulated in m^3/h;

f) Weight of heat exchanger, when empty in kg;

g) Oil filling in litres; and

h) Year of manufacture.

Sufficient space shall also be provided on the rating plate for inscribing information concerning commissioning, cleaning, removal of tube test and assembling of the heat exchanger.

10. Despatch — Before despatch, the heat exchangers shall be thoroughly cleaned internally so that they are ready for use without requiring any further work to be done on them. The oil and water connections shall be blanked.

11. Installation and Operation — Correct installation and preventive maintenance programme are the user's responsibilities.

11.1 *Clearance for Dismantling* — For straight tube exchangers fitted with removable bundles, sufficient clearance shall be provided at the stationary head and to permit removal of the bundle from the shell, adequate space shall be provided beyond the rear head to permit removal of the shell cover and/or floating head cover.

11.2 *Foundation Bolts* — The foundation bolts to the base mounted heat exchangers shall be loosened at one end of the unit to allow free expansion of shells. Slotted holes in supports are provided.

The equipment like HP heaters where the tubes are of mild steel, nitrogen purging inside is done for protection against rusting during long storage. In case the tube material is non-ferrous nitrogen purging is not required. The procedure for nitrogen purging is given in Appendix A.

11.3 *Levelling* — Exchangers must be set level and square so that the pipe connections may be made without forcing.

11.4 *Operation* — Heat exchangers which are not in operation must be either empty on the water side or also must carry a continuous flow.

APPENDIX A

(*Clause* 11.2)

NITROGEN PURGING PROCEDURE

A-1. General — The equipment, such as HP Heaters, live steam tube nest and bled steam tube nest after hydraulic test are dried and nitrogen purged inside for protection against the rusting of the tube nest. The tube nest for the above equipment is of mild steel tube without any protective coating. Hence, maintaining the inert atmosphere with nitrogen inside the equipment is a must. The nitrogen pressure should be 0·35 to 0·70 bar.

A-2. Check

A-2.1 Immediately after receiving the equipment at site, the following checks should be carried out:

a) Pressure gauges fitted for indicating the nitrogen pressure are in good condition.

b) Check leak tightness of all connections and nipple arrangement. Use soap water for leak detection.

A-2.2 a) Replace the pressure gauges if found damaged.

b) Blank the connections properly to avoid any leakage and change joints, if required.

c) Replace the nitrogen purging nipple, if required.

A-3. Maintenance of Nitrogen Pressure

A-3.1 To maintain a pressure inside the equipment, periodic refilling is a must. Refilling cycle depends upon the tightness of the joints/connection blanks.

Remove the cap of the refilling attachment and connect the nitrogen cylinder with the pipe to the nipple provided. Nipple provided is the same as normally used on scooter tubes, hence the cap for fitting the nitrogen is same as that for the scooter air refilling. Figure 6 shows the refilling of the nitrogen.

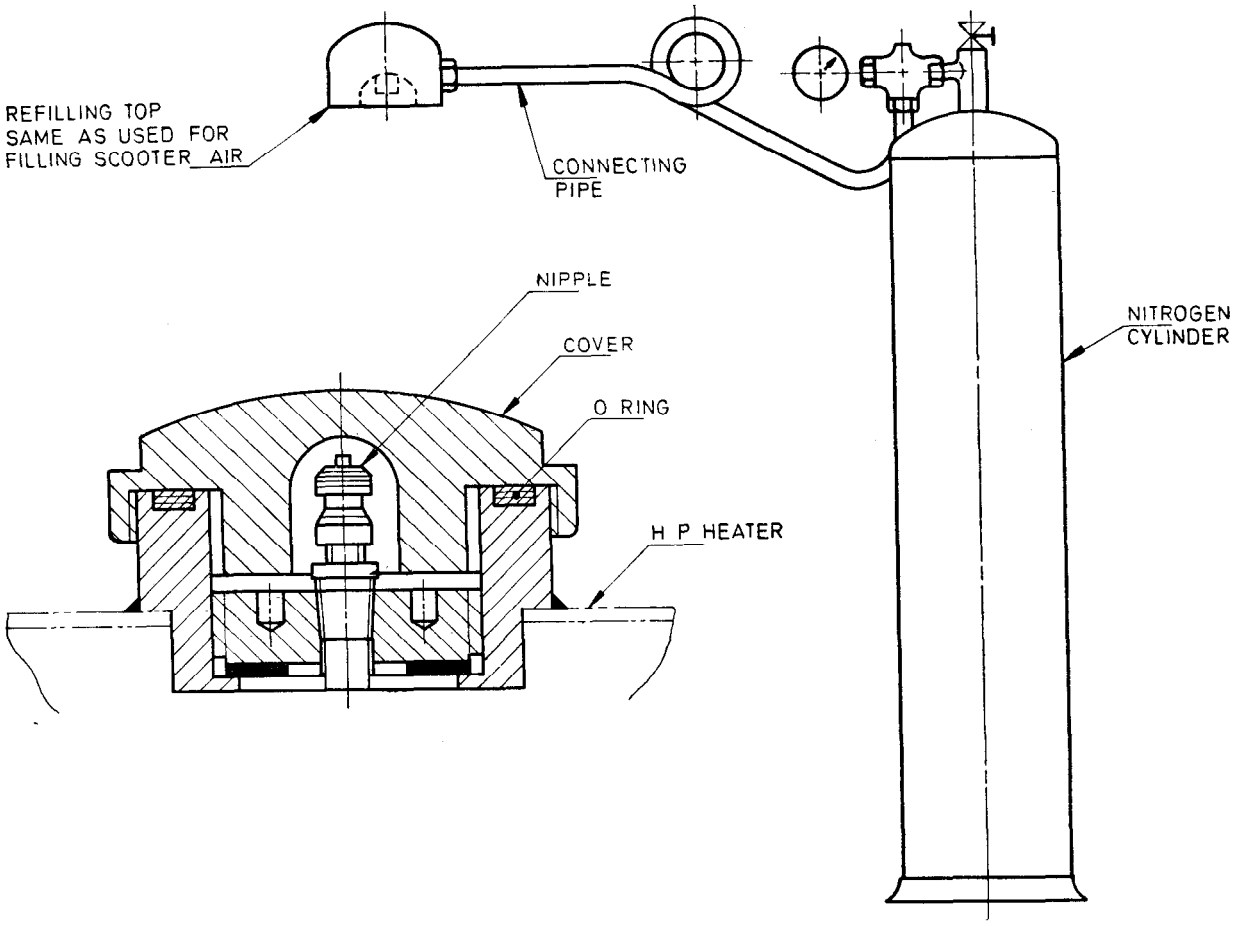


FIG. 6 REFILLING OF NITROGEN

EXPLANATORY NOTE

This standard was originally issued in 1971. In this revision, the following important additions have been made:

a) The heat exchanger ratings have been given from 50 to 1 600 kW while in earlier edition, ratings up to 350 kW were given.

b) The requirements for tube plates, tubes and baffles have been revised based on current trade practices in the industry.

c) Another clause on installation and operation has been added.

d) Procedure for nitrogen purging has been included.

In the preparation of this standard, assistance has been drawn from DIN 42556 Part 1 'Oil to water heat exchangers for transformers, vertical arrangements'; issued by the Deutscher Normenausschuss.

Printed at New India Printing Press, Khurja, India